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INTERIM REPORT TO THE NATIONAL SCIENCE BOARD

National Science Board Commission on Precollege Education in Mathematics, Science and Technology

January 1983

National Science Board
National Science Foundation

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NATIONAL SCIENCE BOARD
NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

NSB COMMISSION ON PRECOLLEGE
EDUCATION IN MATHEMATICS,
SCIENCE AND TECHNOLOGY

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January 20, 1983

Dr. Lewis M. Branscomb
Chairman
National Science Board
National Science Foundation
Washington, DC 20550

Dear Dr. Branscomb:

It is our privilege to transmit to you the first interim report of the National Science Board Commission on Precollege Education in Mathematics, Science and Technology, as required by our charter. This report summarizes the NSB Commission's activities to date.

We are gratified to note at this time evidence of increasing concern about and action toward improving precollege education in mathematics, science and technology in this country. This increase in concern and activity can be seen in all sectors of society. As suggested in the Commission's first report, Today's Problems, Tomorrow's Crises, a national consensus on the importance of a broad understanding of these fields for all students is a prerequisite for the success and persistence of any improvements this Commission may recommend in the Nation's educational systems.

Transmittal of this report to you marks the formal beginning of the third phase of the Commission's activities, directed explicitly toward developing its eventual recommendations. Throughout this third phase, we shall continue to interact with the numerous groups and individuals with interest and roles in precollege education in mathematics, science and technology, so that we may continue to benefit from their advice and counsel as we move toward the completion of our work.

Sincerely,

Cecily C. Selby

William T. Coleman, Jr.   Cecily Cannan Selby

NATIONAL SCIENCE BOARD COMMISSION ON PRECOLLEGE EDUCATION IN MATHEMATICS, SCIENCE AND TECHNOLOGY

Interim Report
January 1983

The National Science Board established the Commission on Precollege Education in Mathematics, Science and Technology in April 1982, in response to a growing concern about the Nation's ability to provide the kind and quality of education at the precollege level that our increasingly scientific and technological society requires. A high quality education in these fields is needed for all students if the United States is to be economically and militarily secure, if its workers are to be equipped for the jobs of tomorrow, and if its citizens are to be able to develop and participate fully in the society of the future.

Some of the problems facing the Nation's educational systems are reflected in a well-documented decline in student participation and achievement in mathematics, science, and technology just when the forward momentum of society depends increasingly on these fields. The Commission's first report, *Today's Problems, Tomorrow's Crises,* issued in October 1982, pointed to the danger the Nation faces of raising a generation of Americans with inadequate understanding and skills to participate fully in the world in which they will live and work. The growing shortage not only of superior teachers but of adequate teachers of secondary school science and mathematics, the inadequacy of instructional time, equipment, and facilities, the failure of coursework to reflect the needs of tomorrow, and the need for new instructional technologies and approaches to reach all students of today, were cited in that report as major problems relating to the decline in student participation and achievement.

Underlying these issues and, in the Commission's view, constituting the root cause of declining student interest and performance, is the lack of a public consensus that a broad understanding of mathematics, science and technology is necessary for all students. In its first report, the Commission termed this lack of consensus "tragic for our society as a whole." The costs of failing to prepare all of our children for today's world and that of the future will be deep and enduring—not only for them as individuals but for our Nation's democratic processes, our economy, and our national security.

Mission and Organization of the Commission

The NSB Commission was convened to address problems whose existence—if not whose full complexity—is already well-documented. Thus, the Commission was not established to conduct another study of the "precollege education problem." Rather, the Commission's charge, its three principal goals, and its plan of organization and operation are action oriented.

Commission Charge

As charged by the National Science Board, the Commission is to:

1. Examine the existing evidence on the quality of precollege (all classes, K-12) education in mathematics, science and technology;
2. Identify where current practices and policies fail to ensure the entry, selection, education and utilization of the full range of potential talent in science, mathematics, and engineering;

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3. Identify and analyze existing mathematics and science programs, teaching materials and teaching techniques whose success may justify imitation or adaptation;
4. Develop an understanding of the roles that all systems—government and private organizations, professional groups and individuals—can play in improving mathematics and science education; and
5. Establish a set of principles, options and strategies which can be used to improve the quality of science and mathematics education.

Commission Goals

The Commission is responding to the charge from the National Science Board in the context of three goals the Commission holds for the Nation's formal and informal educational systems as they relate to mathematics, science and technology. These goals were agreed upon by the Commissioners at their first meeting in July 1982 and direct their work.

- To continue to develop and to broaden the pool of students who are well prepared and highly motivated for advanced careers in mathematics, science and engineering;
- To widen the range of high-quality educational offerings in mathematics, science and technology at all grade levels, so that more students would be prepared for and thus have greater options to choose among technically oriented careers and professions; and
- To increase the general mathematics, science and technology literacy of all citizens for life, work and full participation in the society of the future.

Organization of Activities

The charges to the Commission can be viewed as time-sequenced: there is a need to be clear about the problems being approached (Charge #1 above) before it is possible to determine and evaluate accurately the effectiveness of current policies and practices related to those problems (Charges #2, 3, and 4). Then, there must be understanding of current policies and practices before effective recommendations can be developed (Charges #4 and 5). The Commission has organized its activities accordingly and is addressing the charges in order.

The first of the charges, concerned with defining the specific problems to be addressed, was accomplished in July 1982, at the Commission's first full meeting, and a formal report defining and describing those problems was published in October 1982. This report, ***Today's Problems, Tomorrow's Crises,*** was transmitted to the National Science Board and, in keeping with the NSB Chairman's recommendation, has been distributed widely. Over 27,000 copies of this report have been circulated to date, including a copy to each of the Nation's 16,500 school districts.

The Commission's work since July has been directed toward the second, third and fourth charges listed above. During this phase of activity, the Commissioners are examining current educational practices and considering programs and policies which offer the greatest potential for helping to realize the goals for the Nation held by the Commission.

The next phase of activity, developing the Commission's final recommendations, was begun in January 1983.

Growing Awareness and Concern

One of the purposes of the Commission's activities thus far has been to determine what the various sectors of society view as the critical changes needed in America's precollege educational systems. It is still too early to generalize from the Commission's discussions with diverse institutions and individuals or to recommend any single most important change or simple set of changes. However, there are many indications of growing awareness and concern in all sectors that significant changes are needed. Many groups with which the Commission has met or corresponded concur that precollege education in mathematics, science and technology should be a higher priority item on all agendas.

Increased awareness of the need for change and for greater involvement can be seen in all sectors. The large number of hearings held and bills introduced in the Congress related to precollege education is one such indication. The Executive Office of the President has indicated in discussions with Commissioners the Administration's growing concern for the Nation's educational systems. The subject of precollege mathematics and science education is a major item in the discussions of the Department of Education's National Commission on Excellence in Education.

There also are indications of increased awareness at the level of State and local governments. Significantly, many states, including Arizona, California, Delaware, Florida, Minnesota, New Jersey, North Carolina, Texas, Virginia and Wisconsin have established their own task forces and are developing plans to increase their science and technology capabilities. In all cases, precollege education in these fields is included as a high priority item. The States have recently joined with educators and industry representatives in a Task Force on Education for Economic Growth, established through the leadership of the National Governors' Association. Some local school districts have moved to address precollege educational deficiencies and difficulties, with particular emphasis on mathematics, science, and computer literacy.

Precollege mathematics, science and technology education problems have been featured in many national media presentations. Most major TV networks have aired discussions of the problem within the past six months.

A large number of professional societies and organizations are focusing attention on precollege education in mathematics, science and technology. The National Academy of Sciences and the National Academy of Engineering convened a national convocation in May 1982 to consider the state of precollege mathematics and science education. The American Association for the Advancement of Science has recently formed a Coalition for Education in the Sciences, to increase the involvement of professional scientists and engineers in precollege mathematics, science and technology education.

Major professional teacher organizations have recently completed studies dealing with science and mathematics and have issued policy recommendations for actions in the years ahead. For example, the National Council of Teachers of Mathematics has coupled a study, ***Priorities in School Mathematics,*** with the findings of two mathematics assessments carried out by the National Assessment of Educational Progress to produce ***An Agenda for Action: Recommendations for School Mathematics of the 1980's.*** The National Science Teachers Association recently published a position statement, ***Science-Technology-Society: Science Education for the 1980s,*** and the National Association of Biology Teachers has just published a report, ***New Directions in Biology Teaching: Perspectives for the 1980s.*** The National Education Association is underwriting a series of publications devoted to individual content areas, and the American Federation of Teachers has invited experts in mathematics and science education to consult with AFT decisionmakers.

There is evidence of increasing interest and activity in the business community, which long has been active in precollege education, although in many cases to a limited degree. The importance of precollege education to business and industry was emphasized by a recent study by the New York Stock Exchange, ***People and Productivity: A Challenge to Corporate America.*** That study suggested that many problems in American business productivity may well be related to the quality of this country's precollege mathematics and science educational systems. Such major organizations as The Conference Board, the Committee for Economic Development, and the Business-Higher Education Forum are looking at the precollege education problem in an effort to understand what business and industry can do to help.

Thus, during the first six months of its work, the Commission has observed a marked increase in concern about precollege mathematics, science and technology education in all sectors of our society and a growing awareness that changes are needed. However, there is not yet agreement about the particular changes that should be made, about who should effect them, or about how changes might best be implemented. One of the important prerequisites for any change is agreement about the goals to be met. The Commission has not yet seen such agreement about educational goals, although it is clear that all sectors examined are playing a more active role in setting them. One way the Commission might be helpful in later stages of its activity is through integrating the perspectives of those various groups. Real and enduring improvements in the U.S. educational systems probably will come only from a concerted and sustained effort involving partnerships among all sectors of society.

Highlights of Commission Activities to Date

After satisfying the first of its charges at the July 1982 meeting, the Commission organized itself into four Task Groups, whose activities have been directed primarily at Charges 2 through 4. Those charges involve analyzing current policies and practices affecting precollege education (#2), examining existing approaches to improving precollege education (#3), and considering the roles that various sectors of society can play in bringing about changes in the Nation's precollege educational systems (#4).

Since the July meeting, each Task Group has focused on the policies, activities, roles and relationships of one set of groups with interests in the area of precollege mathematics, science and technology education:

- The Task Group on Governments focuses on the perspectives and activities of Federal, State and local governments, including local school boards;
- The Task Group on Educators focuses on those individuals involved directly in the education of students, including teachers, principals, other school administrators, and curriculum developers;
- The Task Group on Facilitators focuses on groups which indirectly affect or facilitate education, such as professional associations, private and corporate foundations, business and industry, museums, and the media; and
- The Task Group on Recipients focuses on institutions and organizations, such as private industry, the military, and institutions of higher education, that employ or receive students who emerge from the precollege educational system.

Each Task Group of four or five Commissioners has added from three to five additional members to broaden the expertise of the Group. A full listing of Task Group members is provided in Appendix I.

Since July, Task Group members have been meeting with a large number of individuals and groups and have been visiting a wide range of institutions. A detailed listing of site visits made, meetings attended, and groups contacted is provided in Appendix II.

In addition to activities of the individual Task Groups, the Commission has met three times as a group since its first meeting in July 1982—in October and December 1982 and in January 1983. The Commission also held its first public hearing on December 15, 1982, at the Fernbank Science Center in Atlanta, Georgia. That hearing focused on the issue of access to high quality precollege education in mathematics, science and technology for all citizens.

Some highlights of both individual Task Group and full Commission activities follow.

Task Group on Governments

Since its first meeting in July, the Task Group on Governments has met with representatives of Federal, State, and local governments, including local school boards, to obtain their views of the condition of precollege mathematics, science, and technology education, of the major issues involved, and of the current and potential roles of Federal, State and local governments in this area.

Meetings have been held with representatives of White House policymaking offices, Federal agencies, Congressional committees, and national associations representing the states. The latter have included the National Governors Association, National Conference of State Legislatures, Education Commission of the States and others. The Task Group was represented at the annual meetings of several of these organizations.

Three days of intensive discussions were held by the Task Group with education policymakers in Arizona, including the Governor, state legislators, the Superintendent of Education, Board of Education President, School Board Association Director, and other education officials at the state level. This state was selected because its elementary and secondary school enrollment increased at a faster rate in the 1970s than that of any other state, it has been cited as a model for joint educational and industrial development programs, and it recently announced a major program to upgrade precollege mathematics and science education.

The Task Group was represented in discussions with California gubernatorial, legislative, and higher education representatives; at the first session of the newly formed Virginia Governor's Task Force on Science and Technology; and at a Wingspread Conference on new directions in Wisconsin's science education. Contacts and exchanges have occurred with the North Carolina Governor's Task Force on Science and Technology, the Maryland Governor's Science Advisory Council, and the Delaware Governor's Task Force, among others. Steps are being taken to obtain a complete inventory of state initiatives in precollege math and science education.

The Governments Task Group has added to its membership a state governor, state legislator, president of a state school board association, president of a state board of education, and president of a local school board. Six of the nine Task Group members are present or former local school board members.

Task Group on Educators

The Task Group on Educators has engaged in a number of activities focused particularly on the needs of students and teachers in the classroom. It has solicited the views of outstanding teachers at the precollege level on what must be done if mathematics, science, and technology education at this level is to be improved. Financial support has been provided to the National Science Teachers Association to continue its work of identifying illustrative school programs in the sciences and the factors that contribute to their effectiveness. The Task Group has also identified companies that provide creative computer programs for science and mathematics education.

In the important area of curriculum, the Task Group has undertaken a number of initiatives. The Conference Board of the Mathematical Sciences convened a meeting to determine what should be considered fundamental in today's K-12 mathematics curricula. A report was presented to and discussed by the full Commission (see below). Similar efforts are being conducted for precollege curricula in the physical sciences by the American Chemical Society and, for precollege education in technology, by the NSF Engineering Advisory Committee. At the request of the Task Group, the Federation of Behavioral, Psychological and Cognitive Sciences organized a meeting in December to identify findings from cognitive research which have implications for precollege teaching and learning.

The Task Group on Educators has added to its ranks an applied mathematician from industry, a computer education specialist and an elementary school assistant principal who has also been a science teacher.

Task Group on Facilitators

A series of meetings has been held by this Task Group. A large variety of groups have participated, including professional associations of scientists and engineers and of science and mathematics teachers, higher education associations, private and corporate foundations, major industries that have initiated educational efforts at the precollege level, associations of science and technology centers, and various media groups.

These meetings have focused on what these groups and organizations see as possible avenues of action in their role as indirect educators or facilitators, and ways in which the Commission can be helpful to them. Functioning in a number of ways—as opinion leaders, developers of public awareness, producers of educational programs for schools, museums, and the media, purchasers of advertising, or representatives of those directly involved in the education process—these groups have an important bearing on education at many points.

In addition, Task Group members have met with such educational institutions as the Educational Testing Service and the College Board and with representatives of major business groups, the AFL-CIO, publishers' associations, and others.

Additions of persons to the Task Group thus far include the vice president of a major private foundation, a key education official from an association of science societies and the executive director of an association representing a group of science and technology museums.

Task Group on Recipients

This Task Group has focused on business and industry, the higher education community, and the military as employers and teachers of students emerging from secondary schools. It has been recognized, for example, that business and industry and the military play significant roles as educators. This includes the provision of remedial education to compensate for inadequacies at the precollege level.

Major meetings held by the Task Group have included discussions with representatives of the petroleum, electrical, manufacturing, banking, and life insurance industries to discuss how well business and industrial manpower needs are being met. These meetings also focused on ways these groups are now collaborating and might increasingly collaborate with education institutions and units of government to help upgrade precollege mathematics and science education.

This Task Group also held a meeting with 30 representatives of the higher education community to discuss the problems they perceive and to hear how this community can contribute to strengthening precollege mathematics and science education. Representatives of a variety of institutions of higher education reported the trend toward increased remedial instruction in mathematics on their campuses, regardless of differences in student populations or in admissions criteria. Examples of colleges and universities working with local schools to improve these problems were noted.

Attendees at this meeting of higher education representatives also suggested to the Commission that what is most important for entering students is facility in mathematics. Mathematics and science faculty want students to have interest in and curiosity about science. However, these individuals argued that, in terms of what entering students need, strong high school preparation in mathematics to the precalculus level is most important for making all of science, as well as mathematics, viable options for students to pursue.

The Task Group on Recipients has also been meeting with representatives of the military to learn about ongoing programs, such as those conducted by the DoD's Office of Research and Laboratory Management, and those of the Defense Communications Agency, involving high school student apprenticeships in science and engineering, work-study programs, and other efforts to interest them in science and engineering careers.

The Task Group on Recipients has added three members: an official in charge of education programs for a leading chemical corporation, the president of a higher education association, and the director of corporate contributions for a major oil company.

Some Commission-Wide Activities

In addition to meetings and activities related to the work of the individual Task Groups, the Commission has carried out a variety of activities that cut across Task Group lines. One such ongoing activity is concerned with examining the question of what are the fundamentals of mathematics, science and technology that all students must know. A part of this activity was a workshop organized by the Conference Board of the Mathematical Sciences that grew out of the Commission's first meeting. That workshop expressly addressed the question of what should be considered fundamental or essential in the mathematics K-12 curriculum, and the Executive Summary of the CBMS report to the Commission is attached to this report as Appendix III. Similar investigations into the fundamentals of other disciplines are now in planning stages.

The Commission held its first public hearing on December 15, 1982, at the Fernbank Science Center in Atlanta, Georgia. The topic of the hearing was "Access to High Quality Education in Mathematics, Science and Technology for All Citizens." The need to ensure access to high quality education for all students is emphasized by all three of the Commission's goals. The topic of access was considered in the broadest sense. Testimony was presented by students and other individuals from across the country with experience in a variety of existing programs, including those directed toward increasing access in rural and urban settings and to increasing the participation of women, minority, physically handicapped, and economically disadvantaged students in precollege education. The emphasis in testimony was on special features of, or lessons learned from, existing programs that have implications for all groups of students. The agenda for the hearing is attached to this report as Appendix IV.

A number of points were raised at the December hearing that will receive additional consideration as the Commission's work proceeds. For example, many speakers suggested that "positive intervention" or "enrichment" approaches are now being used more than are traditional "compensatory education" or "remedial" instruction approaches. The point was made that major predictors of success in mathematics and science include getting students into a specific precollege mathematics sequence and/or into individualized counseling and support programs and building up good academic habits at early levels. Speakers also emphasized the need for collaboration among local schools, colleges, industries and parents in designing and implementing new precollege programs. As a final example, some speakers asserted that teacher training in the future may well be different from teacher training in the post-Sputnik era. Teachers of the future may become facilitators of learning, rather than dispensers of new knowledge. Therefore, teacher training approaches may need reevaluation.

Speakers at the hearing also pointed out the usefulness of computers in instruction at all grade levels. They also suggested teleconferencing as a means of providing inservice education for teachers. A full transcript of the hearing is available on request from the Commission Office.

A third example of Commission-wide activity is provided by the Commission's beginning deliberations on the relationship between technology and education. As expressed in ***Today's Problems, Tomorrow's Crises,*** Commissioners have already recognized the need to educate students about technology. Over the coming months, the Commission will also be considering the effects of technological advances on the processes of teaching and learning. There is already evidence that the educational enterprise could be altered dramatically by advances in the technology of learning. The potential of computers, telecommunications, information data bases, and other high technology equipment and resources must be carefully evaluated to determine their optimal use in teaching and learning. Major changes in educational methodology may have an overwhelming impact on the direction of future educational activities. This topic of technology and education was a principal focus of the January 1983 Commission meeting and will remain a subject for ongoing deliberation as the Commission carries out its remaining charges.

It should be mentioned as a final note that many of the Commission's activities have had and will continue to have a positive impact on the level of public awareness about the need for a broad understanding of mathematics, science and technology for all citizens. As listed in Appendix II, the Commissioners have been very active in meeting with different groups and in articulating the precollege education problem to numerous audiences. Commissioners have addressed many professional and civic organizations and have presented testimony before Congress. The public hearing in Atlanta received wide news coverage, and portions of the hearing, as well as a discussion involving Commissioners of precollege education issues, were televised nationally. These public awareness activities will continue throughout the Commission's work.

NSB Commission on Precollege Education in Mathematics, Science and Technology

Task Group Membership

GOVERNMENTS

Bruce E. Babbitt, Governor of Arizona
Victoria Bergin, Texas Education Agency
Daniel J. Evans, The Evergreen State College
Pat Collier Frank, Florida State Senator
Elizabeth Kenyon, Rhode Island Association of School Committees
Ann Leavenworth, California State Board of Education
Arturo Madrid, II, National Chicano Council on Higher Education
James R. Oglesby, University of Missouri
M. Joan Parent, (Chair) National School Boards Association

PRIMARY EDUCATORS

Ludwig Braun, New York Institute of Technology
Doris R. Ensminger, Millbrook Elementary School
Katherine P. Layton, (Chair) Beverly Hills High School
Ruth B. Love, The Chicago Board of Education
Frederick Mosteller, Harvard University
Henry Pollak, Bell Laboratories
Herbert A. Simon, Carnegie-Mellon University

FACILITATORS

George Burnet, Jr., Iowa State University
William H. Cosby, Jr., Entertainer/Educator
Robert E. Larson, Systems Control, Inc.
Gerald D. Laubach, Pfizer, Inc.
Robert W. Parry, (Chair) University of Utah
David Z. Robinson, Carnegie Corporation of New York
F. James Rutherford, American Association for the Advancement of Science
Bonnie VanDorn, Association of Science-Technology Centers

RECIPIENTS

Lew Allen, Jr., (Chair) California Institute of Technology
Patricia Albjerg Graham, Harvard University
William F. McDevit, E. I. DuPont de Nemours & Co.
Dale Parnell, American Association of Community and Junior Colleges
Benjamin F. Payton, Tuskegee Institute
Joseph E. Rowe, Gould, Inc.
Terry T. Saario, Standard Oil of Ohio
John B. Slaughter, University of Maryland

NSB Commission on Precollege Education in Mathematics, Science and Technology

Activities Highlights

The following are highlights of activities recently carried out or planned for the immediate future by the members and staff of the National Science Board Commission on Precollege Education in Mathematics, Science and Technology. These activities can be grouped, for convenience, into four categories: (1) Commission initiated workshops, meetings and panel discussions, (2) site visits, (3) formal meetings or conferences attended by Commissioners and staff, and (4) individual meetings with representatives of various organizations, institutions and associations.

Commission Workshops, Meetings and Panel Discussions

- September 7, 1982: Panel meeting at Pfizer Headquarters, New York City, with representatives of the media, various professional societies, and private foundations.
- September 20, 1982: Panel meeting at The Conference Board, New York City, with representatives of major businesses and industries; a major study by The Conference Board has been planned as a result of this meeting.
- September 21-22, 1982: Meeting and discussions, in Washington, D.C., with representatives from major executive branch agencies (including the Executive Office of the President) and from the Congress.
- October 20, 1982: Meeting, in Washington, D.C., with representatives of American Federation of Teachers and National Education Association.
- November 16, 1982: Meeting, in Washington, D.C., with representatives of the higher education community to discuss their needs and role in precollege education.
- November 18, 1982: Panel meeting, in Washington, D.C., with representatives of industry, professional societies, foundations, science museums, and a national student organization.

Site Visits

Both Commissioners and members of the staff have visited a range of programs designed to improve precollege education in mathematics, science and technology over the past two months, including:

- North and South Carolina, including North Carolina School of Science and Mathematics, Governor Hunt's office, Charleston (S.C.) Higher Education Consortium, Control Data Corporation.
- E.I. Du Pont de Nemours and Co.; met with Vice Chairman, Executive Director of Committee on Educational Aid, managers of research and public affairs departments.
- Chicago Museum of Science and Industry; met with Director of Education.
- Sacramento, CA; met with former State School Board President, state legislators, representatives of University of California, Governor's Office, and Office of Appropriate Technology.
- Lyons Township (IL) High School Computer Literacy Project
- National Zoo; met with Director of Education
- Phoenix, Tempe and Tucson, AZ; met with Governor of Arizona, members of Arizona house of representatives and senate, Executive Director of State School Boards Association, State Superintendent of Education, President of State Board of Education, representatives from Arizona State University and University of Arizona, and superintendent, principals, teachers and other representatives of Mesa, Arizona, school district
- Springfield, IL; met with Presidents of central Illinois institutions of higher education, representatives of Illinois Board of Higher Education, Board of Regents-State of Illinois, Board of Governors of State Colleges and Universities, Superintendent of Schools.
- Madison, WI; met with administration and faculty of University of Wisconsin, discussed programs to improve mathematics and science achievement and retention of students in engineering programs.
- Providence, RI; met with members of the Chemistry Department of Brown University, Division of Chemical Education of American Chemical Society, New England Association of Chemistry Teachers.
- Fairfield, CT; met with teachers from area schools.
- Denver, CO; visited George Washington High School.

Conferences

Commissioners and staff members have represented the Commission at a large number of conferences and meetings, such as:

- Mathematical Association of America
- 12th Annual Convention of the National High School and Junior College Mathematics Clubs
- Conference, convened by Educational Testing Service, to identify methods to increase participation of minorities in science and technology
- Meeting of concerned science and mathematics teachers, University of Montevallo (AL)
- Annual meeting of National Conference of State Legislatures
- Annual meeting of National Governors Association
- Annual meeting of Education Commission of the States
- Conference on "The Status of Science and Mathematics Education on the Precollege Level" (Raleigh, NC)
- Meeting of Governor Robb's (VA) Task Force on Science and Technology
- Workshop organized by the Conference Board of the Mathmatical Sciences on fundamentals of the mathematics curriculum
- Wingspread Conference on the Wisconsin Model for New Directions in Science Education
- Annual meeting of the Council of Graduate Schools
- Annual meeting of the National Science Writers Association
- Hearing held by the Subcommittee on Elementary, Secondary, and Vocational Education, U.S. House of Representatives, at which testimony was given by Commissioners
- National Conference on Studies of the American High School
- Annual meeting of the National Association of Biology Teachers
- Annual meeting, Council of Great City Schools
- Meeting on Transition to Higher Education, Region V, U.S. Department of Education
- Conference on Energizing and Mobilizing Partnerships for Science and Mathematics Education as a National Priority, North Carolina School of Mathematics and Science
- Invitational Conference on Education, American Chemical Society
- Meeting of AAAS Coalition for Education in the Sciences
- Meeting of Council of Scientific Society Presidents
- American Chemical Society Conference on Using Industrial Chemists to Enrich Secondary School Chemistry and Science Education
- Annual Assembly of the American Association of Engineering Societies

Individual Meetings

During the past months, both Commissioners and staff have met formally with representatives of a wide range of societies and organizations, such as:

- Business-Higher Education Forum
- Commission on the Behavioral and Social Sciences, National Research Council
- National Council of Teachers of Mathematics
- Consortium of Social Science Associations
- American Association of Universities
- National Society of Professional Engineers
- National Action Council for Minorities in Engineering
- Council of Chief State School Officers
- Forum of Education Organization Leaders
- National Association of State Boards of Education
- American Education Research Association
- American Association of Physics Teachers
- National Association of Biology Teachers
- American Association of School Administrators
- American Council on Education
- Council of Scientific Society Presidents
- Federation of Behavioral, Psychological and Cognitive Sciences
- American Physical Society
- Council on Foundations
- Association of Science and Technology Centers
- National Association of State Academies of Science
- Spectroscopy Society of Philadelphia
- National Conference of State Legislatures
- Education Commission of the States
- National School Boards Association
- Epcot Center
- Century Association
- Society of Women Engineers
- Educational Testing Service
- National Center for Educational Statistics

APPENDIX III

NSB Commission on Precollege Education in Mathematics, Science and Technology

"The Mathematical Sciences Curriculum K-12: What is Still Fundamental and What is Not"

The Conference Board of the Mathematical Sciences
December 1, 1982

EXECUTIVE SUMMARY

Our charge from the NSB Commission was to identify what parts of mathematics must be considered fundamental for education in the primary and secondary schools. We concluded that the widespread availability of calculators and computers and the increasing reliance of our economy on information processing and transfer are significantly changing the ways in which mathematics is used in our society. To meet these changes we must alter the K-12 curriculum by increasing emphases on topics which are fundamental for these new modes of thought.

This report contains our recommendations on needed changes—additions, deletions, and increased or decreased emphases—in the elementary and middle school mathematics curricula and a statement of more general concerns about the secondary school mathematics curriculum.

With regard to elementary and middle school mathematics, in summary, we recommend:

- That calculators and computers be introduced into the mathematics classroom at the earliest grade practicable. Calculators and computers should be utilized to enhance the understanding of arithmetic and geometry as well as the learning of problem-solving.
- That substantially more emphasis be placed on the development of skills in mental arithmetic, estimation, and approximation and that substantially less be placed on paper and pencil execution of the arithmetic operations.
- That direct experience with the collection and analysis of data be provided for in the curriculum to insure that every student becomes familiar with these important processes. We urge widespread public discussion of the implications of the changing roles of mathematics in society, support of efforts to develop new materials for students and teachers which reflect these changes, and continued and expanded experimentation within the schools.

With regard to the secondary school curriculum, in summary, we recommend:

- That the traditional components of the secondary school curriculum be streamlined to make room for important new topics. The content, emphases, and approaches of courses in algebra, geometry, precalculus, and trigonometry need to be re-examined in light of new computer technologies.
- That discrete mathematics, statistics and probability, and computer science now be regarded as "fundamental" and that appropriate topics and techniques from these subjects be introduced into the curriculum. Computer programming should be included at least for college-bound students.

Modern computer technology clearly has vast potential for enriching and enlivening the secondary school curriculum. However, we are not now in a position to make firm recommendations. There is need for research on the effects of incorporating technology into the traditional secondary school curriculum. We urge federal support for investigations into this question, including development of experimental materials and prototypes of actual school curricula.

Although we are generally optimistic about the future role of computers, we feel we must highlight one point that worries us even though it is not directly within our charge. The disparity of access between children who have a computer at home and children who do not threatens to widen the educational gap that already exists between different economic strata. It is urgent that programs be designed to address this problem.

We clearly recognize that the most immediate problem is not the mathematics curriculum, but the need for more, and better qualified, mathematics teachers. One section of this report is devoted to recommendations on attracting and training prospective teachers, better utilizing the talents of in-service teachers, and retraining teachers who are inadequately prepared for teaching mathematics. We feel that the coming changes in subject matter and emphasis not only will bring a new sense of vitality to K-12 mathematics, but also will encourage teachers actively to seek and participate in programs of professional development.

The Conference Board of the Mathematical Sciences stands ready to assist efforts to develop immediate strategies for addressing the teacher shortage and to develop long-term strategies for bringing about the curricular changes envisioned in this report.

NSB Commission on Precollege Education in Mathematics, Science and Technology

Agenda

Hearing on
Access to High Quality Education in Mathematics
Science and Technology for All Citizens

December 15, 1982
Fernbank Science Center,
Atlanta, Georgia

9:00 a.m. Introductory Remarks

9:15 a.m. Testimony from:

Students from Chicago and Atlanta
Alonzo Crim, Superintendent of Schools, Atlanta
Melvin Webb, Resource Center for Sci. and Eng., Atlanta Univ.
Robert Eilber, North Carolina School of Science and Mathematics
Mary Hiers, Fernbank Science Center

10:15 a.m. Break

10:30 a.m. Testimony from:

Carolyn Chesnutt, Southeastern Consortium for Minorities in Engineering
Barry McLaughlin, Philadelphia Regional Introduction for Minorities to Engineering
Robert Finnell, Math, Engineering, Science, Achievement
Nancy Kreinberg, EQUALS

12:00 p.m. Lunch

1:30 p.m. Testimony from:

John Grant, Dekalb County, GA, School System
Richard Griego, S.W. Resource Center for Sci. Eng., U. New Mex.
Etta Falconer, Spelman College
F. L. Bill Britt, Northeast Educational Center, State of N.C.
Gil Lopez, Comprehensive Mathematics and Science Program
Wayne Steen, University of Oklahoma
Shirley Malcolm, American Association for the Advancement of Science
Deborah Baldridge, Discovery Learning, Inc.
George Thomas, American Indian Science and Engineering Society

3:00 p.m. Break

3:15 p.m. Testimony from:

Lynn Cornett, Southeastern Regional Education Board
William Lnenicka, Georgia Institute of Technology
Kenneth Hill, Detroit Area Precollege Education Program
Elizabeth Abbott, Florida Foundation for Future Scientists
Roger Nichols, Boston Museum of Science
Ted Reid, Educational Systems Development
Lynda Martin-McCormick, Project on Equal Education Rights
Mildred Graham, Georgia State University
D. S. Smith, Bell Laboratories
Barbara Abels, Berry College

4:30 p.m. Adjourn